

APPENDIX C

EXTRACT FROM S.P.T.CO. SUPPLEMENT TO AREA MANUAL

PART 20-a

SUPPLEMENTAL SPECIFICATIONS FOR DESIGN OF SHORINGS

20a-1 GENERAL

Part 20-a is a supplement to part 20 of Chapter 8 of the AREA Manual for Railway Engineering. Where this supplement expands or modifies the AREA Manual, the provisions of the supplement are to be followed.

Shoring which is to be installed adjacent to Railroad operating tracks shall be designed in accordance with the following provisions:

- 1.1 Special railroad permission is required for installation of shoring closer than 8'-6" from the centerline of any operating track.
- 1.2 Shoring between 8'-6" and 10'-0" from face of shoring to centerline of track when excavation is in natural ground or in fill ground which has been placed with proof of adequate compaction control, (also shoring between 8'-6" and 13'-0" when excavation is in fill ground other than compaction controlled fill as stated above), shall be of a type whereby the shoring is installed in place prior to any excavation being performed, and whereby the excavation can be made with no possibility of disturbance or loss of the soil material being retained between the shoring and the track. Common shoring types fulfilling this requirement are interlock edge steel sheet piling, tongue and groove edge precast concrete sheet piling, etc., which are driven into position prior to starting excavation. Shoring types using lagging elements which are placed as excavation proceeds are not permitted within the limits specified in this section.
- 1.3 Shoring outside the limits stated in Section 1.2 may be of types other than stated in Section 1.2 including types using lagging elements which are installed as the excavation proceeds.
- 1.4 Shoring, excavations, pits, etc. shall conform to the requirements of Exhibit 'B' Relations with Railroad Company. Excavations, pits, etc. within 13'-0" from centerline of track shall have protection by Standard handrails.

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Minimum clearance from centerline of track to face of handrails is 8'-6" on tangent track and 9'-6" on curved track.

- 1.5 Where the provisions of this specification are more restrictive than the requirements of the Public Utilities Commission Orders, Department of Industrial Safety, OSHA, or other governmental agencies then these supplemental specifications shall apply.

20a-2 CLASSIFICATION OF SOILS

- 2.1 Soils to be retained. as well as the soils depended upon for structural stability (passive resistance, shear strength, friction, etc.) shall be classified in accordance with the soil types listed in AREA Chapter 8, Part 5, Article 5.2.5. This classification is to be a part of the calculations submitted with the shoring plans, and which is to be verified by a Registered Professional Civil Engineer.

20a-3 LOADS ON SHORINGS

- 3.1 The loading systems of this section apply to shorings which have some degree of flexibility such as cantilever sheet pile walls, or cantilever soldier pile type systems, also sheet pile and soldier pile type systems using tie backs or raker struts in which the tie backs or struts are not preloaded. This Section does not apply to any excavation whereby one side of the excavation is cross-strutted to the opposite side (trench type), nor to tie back or raker strut systems wherein the ties or struts are preloaded.
- 3.2 Level Earth: 36 Lb per foot EFP (Equivalent Fluid Pressure) is the minimum value to be used in designing shoring. This corresponds to Type 2 soil as defined in AREA Chapter 8, Part 5, Articles 5.2.5 and 5.3.2. EFP values for soils in Types 3, 4 and 5 shall be based on the values tabulated in AREA, Chapter 8, Part 5, Article 5.2.5.
- 3.3 Where the ϕ and C values of the soils have been ascertained by borings and tests and the values for the EFP have been established by a Registered Professional Civil Engineer specializing in geotechnical engineering, then these values may be used in lieu of the tabulated values providing the ϕ and C values determined by test have been reduced by 15% to allow for the dynamic effect of train loadings on the retained materials.

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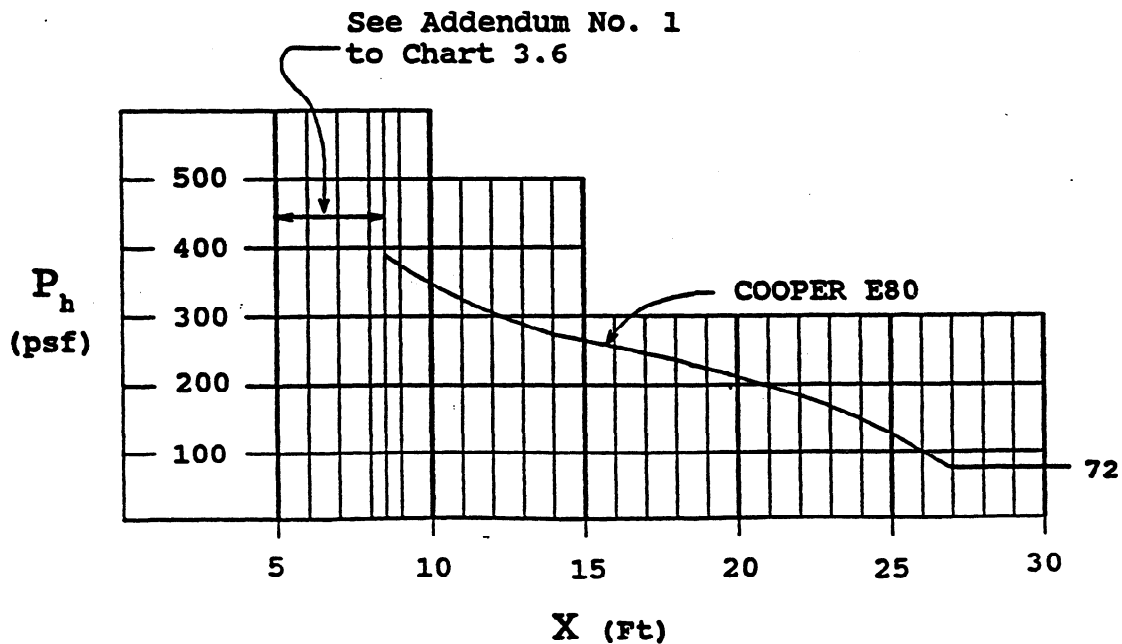
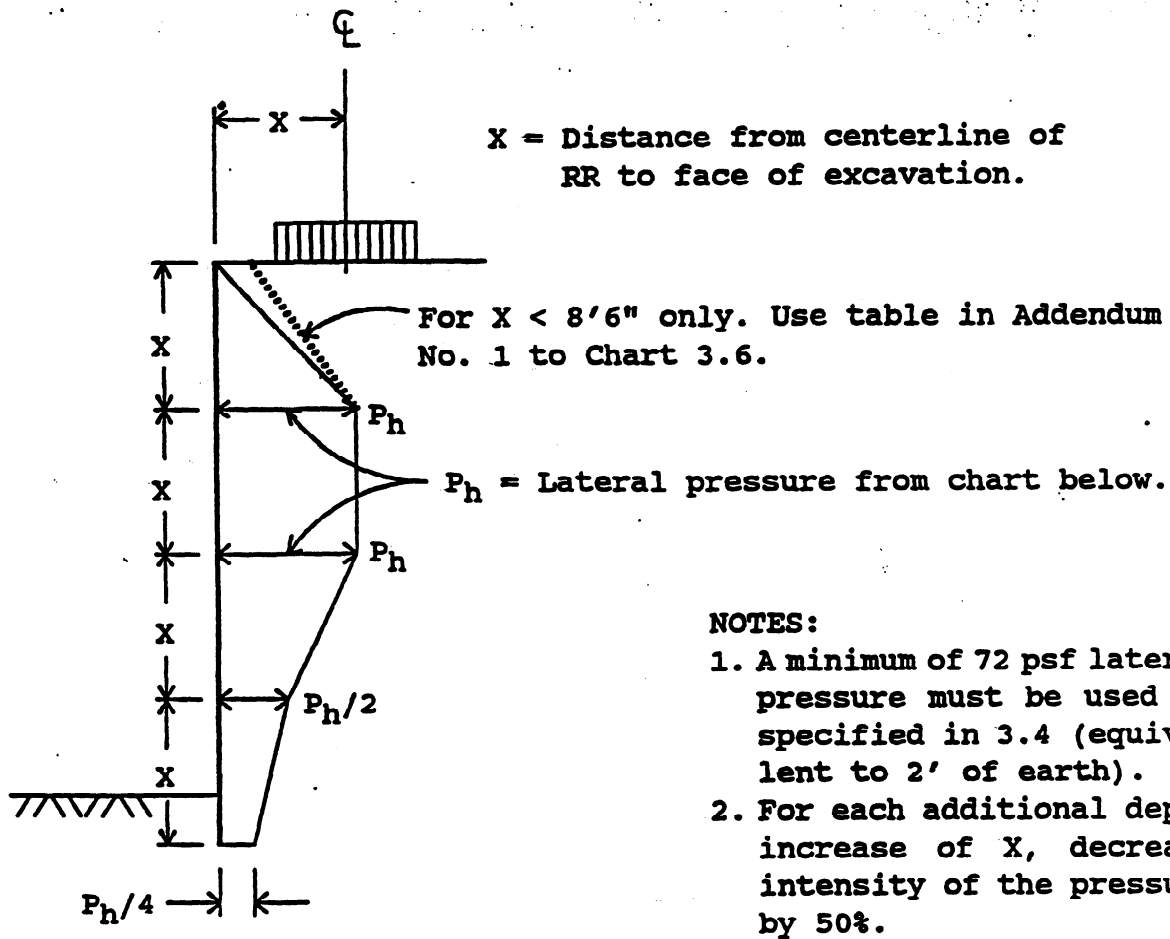
- 3.4 Surcharge: Minimum surcharge to be applied is 2 feet height of 110 p.c.f. earth.
- 3.5 Sloping Surcharge: Minimum EFP values shall be those from the curves for Type 2 soils, Chapter 8, Part 5, Appendix C; Section 3.3 is also applicable to sloping surcharge.
- 3.6 Cooper's E80 Railroad Surcharge Loading. Use values from Chart 3.6 (see next page).
- 3.7 Alternate Computation: The load system of Sections 3.2 through 3.5 can be calculated on the basis of AREA Chapter 8, Part 5, Appendix B, Trial Wedge Method of Earth Pressure Computation. Values from 3.6 must be added to the trial wedge computation to obtain values for total loads.
- 3.7.1 The minimum values for retained soils shall be those stated for Type 2 soil, namely, unit weight = 110 pcf, angle of internal friction $\phi = 30^\circ$, cohesion = 0. Section 3-3 is also applicable to this method, however, the ϕ and C values determined by borings and tests shall be reduced 15% to allow for the dynamic effect of train loadings. This method will handle soils with both ϕ and C characteristics, as well as structures in excess of 20 feet in height.
- 3.8 All retaining structures shall be safe against slip circle type failure.

20a-4 LOADS ON SHORINGS

- 4.1 The load systems in this section apply to excavations whereby one side of the excavation is strutted against the opposite side (trench type) and tie back and raker strut systems wherein the ties or struts are preloaded.

Refer to OSC procedure with RR surcharge load.

CHART 3.6 LATERAL PRESSURE FOR COOPER RAILROAD LIVE LOAD



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Addendum No.1 to Chart 3.6

For lateral pressure values of excavations closer than 8'-6" to center line of track use the following table in lieu of the dashed line of the upper pressure curve of Chart 3.6. The upper pressure curve in Chart 3.6 is to be used for all excavations. All values of X equal the distance from center line of track to the face of excavations.

LATERAL Pressure : P_h (psf)					
$X \rightarrow$ Ft. DEPTH Ft.	8.5	7.5	6.5	5.5	4.5
0	100	100	100	100	100
1	374	500	770	1310	1530
1.5	511	692	1105	1310	1420
2	648	899	1105	1310	1310
2.5	785	899	1105	1208	1208
3	785	899	1105	1105	1105
4	785	899	899	899	899
4.5	785	842	842	842	842
5	785	785	785	785	
5.5	729	729	729	729	
6.5	617	617	617		
7.5	504	504			
8.5	390				

20a-5 ALLOWABLE STRESSES AND FACTORS OF SAFETY

5.1 Structural Steel

Axial Tension = $F_y/1.5$ (24,000 psi for A36 Steel)

Steel Sheet Pile Section, AREA Chapter 8

Anchor Rods, AREA Chapter 8, Part 20 Sect. E, Article 7

Flexural Tension = $F_y/1.5$ (24,000 psi for A36 Steel)

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Axial Compression

New Steel - 1st usage on subject job:

$$F_a = 20,000 - (0.4) (L/r_y)^2$$

Other than above: $F_a = 16,000 - (0.38) (L/r_y)^2$

Flexural Compression: $F_b = (14,400,000)/(Ld/bt) \leq 24,000 \text{ psi}$

5.2 Prestress Strand or Rod

Allowable working stress (other than tie back):

(0.6) (Ultimate Strength)

Allowable working stress (used as tie back):

(0.4) (Ultimate Strength)

(If use as structural element exceeds 30 days, then the strand shall be protected .-from rust).

5.3 Steel Wire Cable

Allowable working load in Lb: Rated Breaking Strength/2.5

(If used as structural element exceeds 30 days then the cable shall be protected from rust.)

5.4 Concrete

All stress allowables to comply with AREA Chapter 8, Part 2.

5.5 Timber

Compression perpendicular to the grain: 450 psi

Compression parallel to the grain: $480,000/(L/d)^2 \text{ psi}$

Maximum = 1,600 psi

Flexural stress: 1,700 psi

reduced to 1,500 psi for members with
a nominal depth of 8 inches or less.

Horizontal shear 140 psi

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5.6 Factors of Safety

For anchor blocks, deadmen, etc.	2.0
In the use of passive pressure for stability	2.0
In the use of soil shear strength and friction based on vertical loads.	1.5
Slip circle failure of structure as a whole, or any part except anchor blocks, deadmen, etc.	1.5
Slip circle failure of anchor bolts, deadmen, etc.	2.0
Soil bearing pressures, U.B.C. Section 29	

5.7 No increase in stresses or reduction in safety factors as tabulated is permitted.

20a-6 SHORING PLANS

6.1 Shoring plans shall consist of the following:

A: drawing showing dimensioned locations with respect to track, plan view, elevations, sections and details. Drawing elements shall be fully dimensioned, materials specified and end connections detailed.

Structural calculations shall accompany the plans and shall show the design basis for the shoring and all elements.

Drawings and calculations shall be prepared by or under the immediate supervision of a Registered Professional Civil Engineer Licensed to use the title "Structural Engineer" or by a Registered Civil Engineer with a minimum of 5 years of experience specializing in the design of shorings. Both drawings and calculations shall be signed by the Registered Professional Engineer.

Three (3) sets of plans shall be submitted for review.

Overpass Clearance and Drainage Requirements follow.

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NOTES

1. DRAINAGE AND EROSION CONTROL:

- (a) To prevent embankment material from sloughing, and drainage water from undermining track subgrade, embankment slopes adjacent to tracks shall be paved with concrete around the curved face to a line opposite the abutment, and self cleaning paved ditches shall be provided to carry waters through the overpass area and disperse them away from the track. These paved slopes and ditches shall be provided at all overpass structures in desert areas, those subject to blowing and drifting sand, and all others where the terrain is such that a build-up of drainage water and flows along the track may be anticipated. Where slopes are not paved, they shall be no steeper than 2 to 1.
- (b) Concrete ditches to be Class B, PCC, 4" min. thick. The dimensions of ditches shown are minimum for locations where expected flows along track are not heavy. The size of ditches will vary depending upon the terrain, and should be designed in accordance with good drainage engineering practices.
- (c) Drainage plans shall be included with general plans for overpass structures submitted by public agencies to the railroad company for approval. If paved slopes and ditches are not included, the covering letter shall explain why they are considered unnecessary.

2 . PERMANENT CLEARANCES:

- (a) Whenever practicable, overpass structures shall be designed to locate all piers and abutments outside of railroad right of way. Permanent clearances as shown are minimum, and greater clearances are preferred when they can be obtained without undue additional expense.
- (b) All piers shall be located beyond outer edges of ditches at top of slopes; however, where special, conditions make this impracticable, the side clearances to piers may be reduced provided adequate drainage facilities are furnished outside of piers) and explanation of such special conditions is submitted along with drainage plans for approval by the railroad company.
- (c) Because of the required minimum temporary construction clearance; to forms, falsework, etc. as specified in Note 3 below,

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it is normally not possible to construct piers with a permanent side clearance of 10'-0" or 11'-0" from center line of track to face of pier, as shown in "Section Away from Slope". A greater clearance is usually necessary, the distance depending upon the method of construction, unless the track is out of service or can be shifted away from pier during construction.

3. TEMPORARY CONSTRUCTION CLEARANCES:

- (a) The following criteria for the use of falsework supporting deck construction adjacent to operating rail lines of the various categories shall be used as general guidelines, subject to deviation only upon the approval of the railroad's Chief Engineer-System:

Category A: Lines with heavy passenger traffic (San Francisco-San Jose is the only line presently in this category).

No falsework of any kind. No cast in place girders. Precast girders erected on permanent bent caps preferred.

Category B: Heavy traffic freight lines, with or without passenger trains.

Minimum horizontal clearance of 14 feet from center line of nearest track to falsework. Temporary collision posts set in 6 feet of concrete and extending not less than 16 feet above top of rail shall be installed on both sides of the bent and located 10 feet clear of the center line of track approximately 100 feet in advance of falsework. Falsework to be sheathed solid on the side adjacent to track between 3 and 17 feet above top of rail elevation. Collision posts and sheathing shall not be required for lines in this category if horizontal clearances to falsework is 18 feet or greater.

Category C: Lightly used freight lines, drill, yard tracks.

Minimum horizontal clearance of 10 feet from center line of nearest track to falsework. Other criteria same as Category B except that collision posts and sheathing shall not be required if horizontal clearance is 14 feet or greater.

- (b) The following minimum temporary construction clearances shall be maintained for placement above top of rail of materials other than falsework (covered in Note 3(a) above), such as piled or

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stored materials, parked equipment, placement or driving of piles, placement of forms, bracing or. other construction supports:

10'-0" horizontally from center line of nearest tangent track or

11'-0" horizontally from center line of curved track.

22'-0" vertically above top of highest rail.

Any proposed temporary clearances less than these must be submitted to the railroad company for review and approval prior to construction, and must be authorized by the utility regulatory body of the state if less than the clearances legally prescribed.

- (c) Excavations for pier footings without shoring of track roadbed shall not be made closer than the limit line shown with slope of 1.6 to 1 starting at subgrade 13'-0" from center line of track. Excavations closer than this sloped limit shall not be undertaken without prior approval by railroad of plans for shoring of track roadbed, and in any instance shall not be approved closer than 8'-6" horizontally from center line of track to near edge of excavation.
- (d) Walkways with railings shall be constructed in accordance with plans approved by railroad over open excavation areas adjacent to tracks within normal road bed, and railings shall not be closer than 8'- 6" horizontally from center line of tangent track or 9' - 6" from curved track.
- (e) Plans and calculations covering all falsework, shoring, excavation supports, etc. adjacent to railroad tracks, which have been certified to be complete and satisfactory by the public agency, shall be submitted to the railroad's Chief Engineer-System for approval before construction is begun.

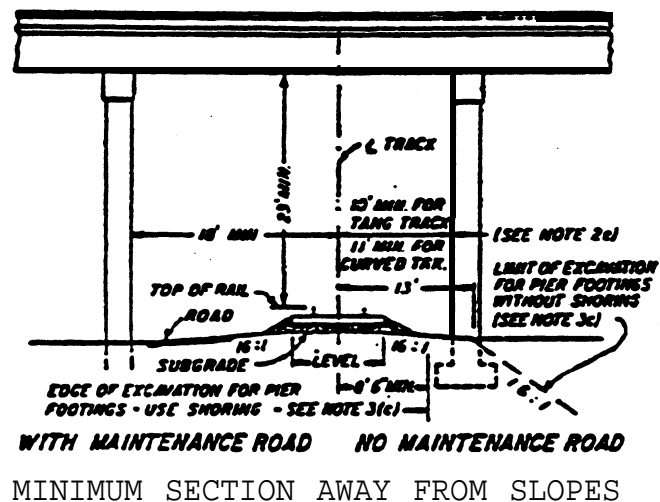
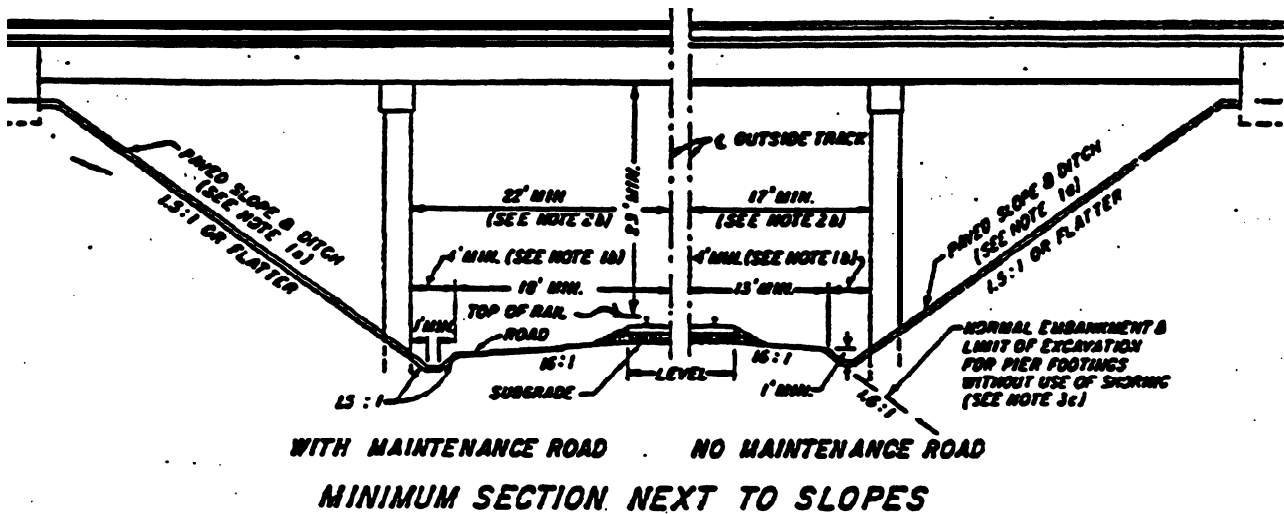
4. DRAWING REFERENCES:

- (a) For details of standard track roadbed and ballast see drawing C.S. 500 for mainline single track, C.S. 520 for main line double track, D.S. 513 for branch lines and sidings, and C.S. 515 for drill, spur and yard tracks. Note references on these drawings to special ballast and roadbed sections required to provide walkways adjacent to switches and tracks where trainmen are required to work on the ground.

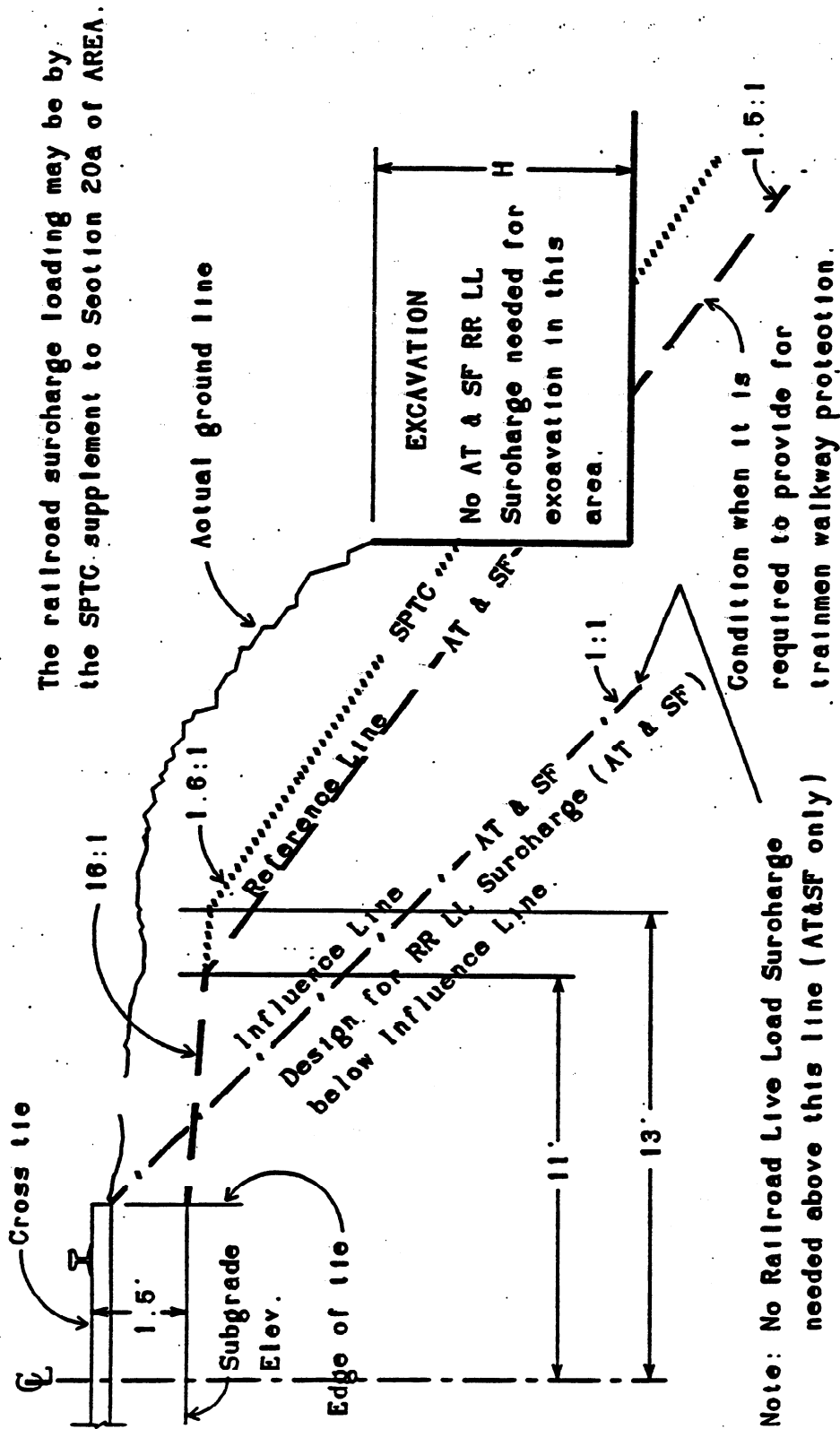
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SOUTHERN PACIFIC LINES COMMON STANDARD

OVERPASS CLEARANCE AND DRAINAGE REQUIREMENTS
NO SCALE ISSUED AUG.30, 1974



REQUIREMENTS FOR EXCAVATION SHORING - THE ATCHISON TOPEKA, AND SANTA FE RAILWAY COMPANY



Generally no shoring will be required if the bottom of excavation is above a railroad reference line and the ground will stand on it's own. Also, for a trench condition where $H > 5'$, shoring is required per Cal-OSHA. The dotted line shows reference line for SPTC (Rev 8-30-74). The SPTC criteria applies to UPRR, WPRR, NWP, SD & AE. Railroads should be notified prior to start of work. Railroad approval will be required for any work within 15'-0" of the center line of track. Shoring that intersects the AT & SF Influence Line must be designed to withstand railroad live load lateral forces. The Influence Line is not to be used for unsupported slope excavations.

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The AREA Manual for Railway Engineering defines soil types in the following manner:

5.2.5 Character of Backfill

Backfill is defined as all material behind the wall, whether undisturbed ground or fill, that contributes to the pressure against the wall. The backfill shall be investigated and classified with reference to the following soil types:

TYPES OF BACKFILL FOR RETAINING WALLS

Type

1. Coarse-grained soil without admixture of fine soil particles, very free-draining (clean sand, gravel or broken stone).
2. Coarse-grained soil of low permeability due to admixture of particles of silt size.
3. Fine silty sand; granular materials with conspicuous clay content; or residual soil with stones.
4. Soft or very soft clay: organic silt: or soft silty clay.
5. Medium or stiff clay that may be placed in such a way that a negligible amount of water will enter the spaces between the chunks during floods or heavy rains.

5.3.2 Computation of Backfill Pressure

Values of the unit weight, cohesion, and angle of internal friction of the back fill material shall be determined directly by means of soil tests or, if the expense of such tests is not justifiable, by means of the following table referring to the soil types defined in Section 5.2.5. Unless the minimum cohesive strength of the backfill material can be evaluated reliably the cohesion shall be neglected and only the internal friction considered.

Soil Type	Unit Weight Lb per Ft ³	Cohesion Lb per Ft ²	Angle of Internal Friction
1	105	0	33° 42' *
2	110	0	30°
3	125	0	28°
4	100	0	0
5	120	240	0

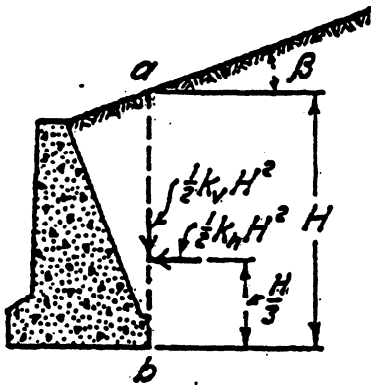
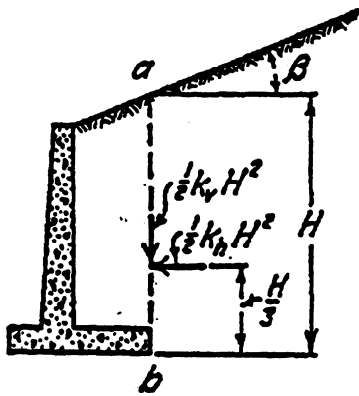
* (38° for broken stone)

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American Railway Engineering Association
C & M Section - Engineering Division - AAR

EARTH PRESSURE CHARTS FOR WALLS LESS THAN 20 FT HIGH

Charts A and B may be used for estimating the backfill pressure if the backfill material has been classified in accordance with Sec. B, Art. 4.



NOTES:

Numerals on curves indicate soil types as described in Sec. B, Art. 4.

For materials of Type 5 computations should be based on value of H four feet less than actual value.

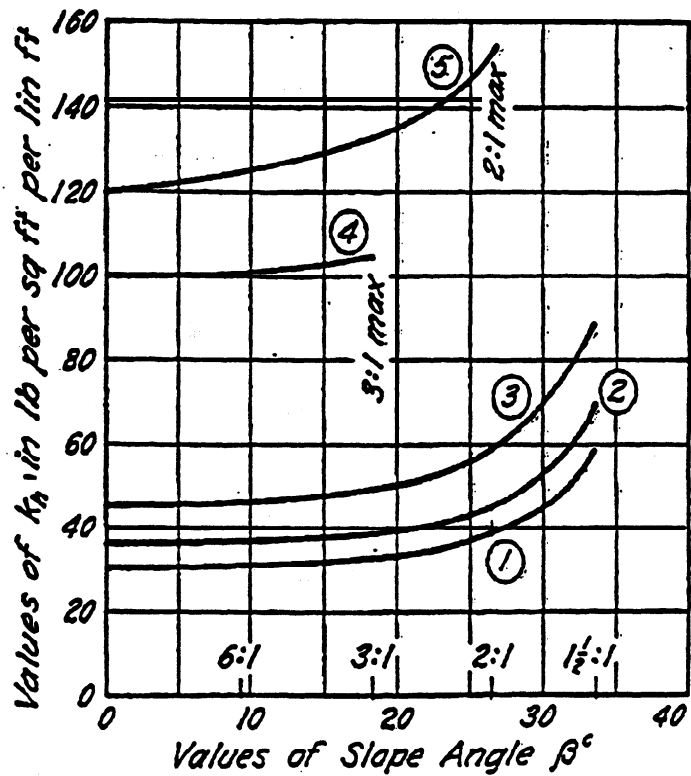
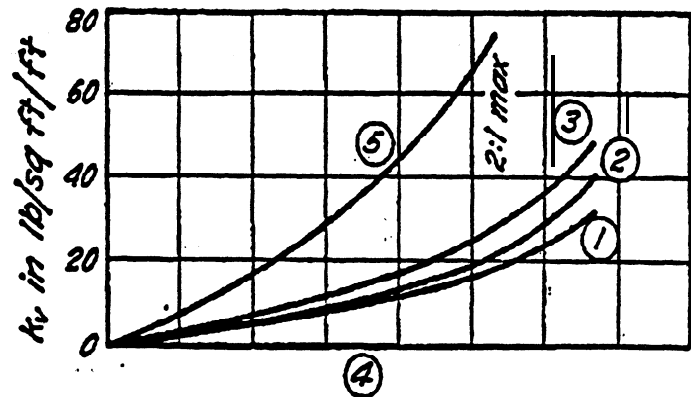


Chart A

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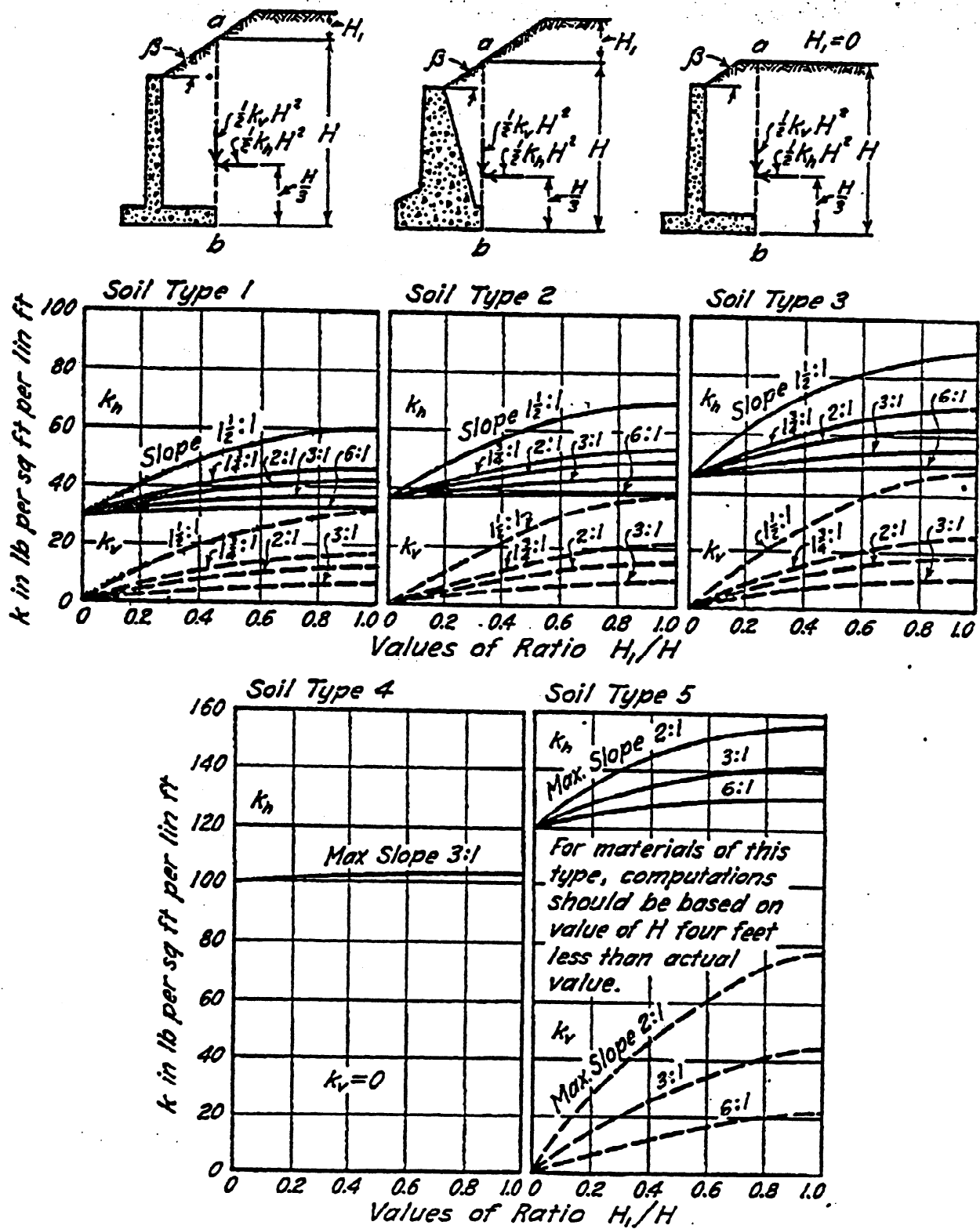


Chart B